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TITLE OF THE INVENTION

METHOD AND APPARATUS FOR IMAGE FORMING CAPABLE OF EFFECTIVELY COLLATING A STACK OF SINGLE-/DOUBLE-SIDED RECORDING SHEETS IN A DESIRED EJECTION TRAY

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for image forming, and more particularly to a method and apparatus for image forming capable of effectively collating a stack of single-sided or double-sided recording sheets in increasing order of pages in a desired ejection tray.

DISCUSSION OF THE BACKGROUND

Some background image forming apparatuses including copying machines, printers, facsimile machines, etc. are capable of performing a double-side recording operation for recording on both sides of a recording sheet. Typically, in the double-side recording operation of these machines, a first toner image is formed on one side of a recording sheet and a second toner image is formed on the other side of the same recording sheet after the first toner image is fixed. Before the second toner image is formed, the recording sheet is reversed. After a completion of the second image forming, the second toner image is fixed and, as a result, a double-sided recording is achieved.

The above-described double-side recording method involves various problems such as difficulty in reversing a recording sheet, unstable sheet transfer due to a paper

curl problem caused by the first fixing process, etc.

On the other hand, published Japanese unexamined patent applications, No. JPAP1-209470 and No. JPAP10-142869, describe an image forming apparatus that transfers toner images to both sides of a recording sheet with two image carrying members and fixes the toner images through one time fixing process.

In the image forming apparatus of the published Japanese unexamined patent application, No. JAPA1-209470, a first toner image formed on a photoconductive member is transferred onto a transfer belt with a first transfer member. Then, a second toner image is formed on the photoconductive member and is transferred onto one surface of a recording sheet with the first transfer member. After that, the first toner image on the transfer belt is transferred onto the other side of the recording sheet with a second transfer ember. Thereby, the first and second toner images are transferred onto both sides of the recording sheet which is then subjected to a fixing process.

A published Japanese unexamined patent application, No. JPAP3-253881, describes an image forming apparatus which is similar to that of the above-mentioned application, No. JPAP1-209470. A difference is that the above-mentioned application, No. 3-253881, eliminates the second transfer member by reversing a polarity of the second toner image on the photoconductive member before it is transferred to the recording sheet. Thereby, the first and second tone images are transferred onto both sides of the recording sheet without the second transfer member.

The image forming apparatus of the published Japanese unexamined patent application, No. JAPA10-142869, is provided with two transfer members and performs one time fixing operation for fixing color images which have been transferred onto both sides of a recording sheet with the two transfer members. This image forming apparatus

uses a guide member including a flat plate on which a plurality of star-like wheels are rotatably mounted to smoothly transfer the recording sheet double-sided with the color images.

However, these image forming apparatuses have a drawback in a stack order of the output recording sheets. For example, as shown in Fig. 1, a stack of recording sheets are output face down in a tray T1 but are face up in a tray T2. Therefore, the stack of recording sheets output to the trays T1 and T2 are different in a page order.

A published Japanese unexamined patent application, No. JPAP2000-19799, described an image forming apparatus that includes a tray switching mechanism for switching between face-down and face-up ejection trays. This application describes a use of a sheet reverse mechanism that makes it possible to switch the ejection trays without changing relationships between images and surfaces of a recording sheet. This application also describes a technique in which the relationships between images and surfaces of a recording sheet are changed when the ejection trays are switched from one to the other in an image forming apparatus having no sheet reverse mechanism.

However, the above-described application, No. JPAP2000-19799, has a drawback in that a thick sheet is not properly transferred. This is because a recording sheet is bent when it is reversed by the sheet reverse mechanism.

In a case that an image forming apparatus having a plurality of ejection trays, as shown in Fig. 1, is applied with the technique for changing the relationships between images and surfaces of a recording sheet, as described in the above-mentioned application, No. JPAP2000-19799, it is not easy for a user to properly instruct the change of the relationships between images and surface of a recording sheet.

Another published Japanese unexamined patent application, No. JPAP2000-

38234, described an image forming apparatus which reads images on both sides of a double-sided original and records the read images on both sides of a recording sheet. In this apparatus, the double-sided original is reversed after a completion of reading one side of the original and the other side of the original is read. In the recording, the recording sheet is reversed after a completion of recording an image on one side of the recording sheet and another image is recorded on the other side of the recording sheet.

Another published Japanese unexamined patent application, No. JPAP11-258864, describes an image forming apparatus which reads images on both sides of a double-sided original by moving the original and records the read images on both sides of a recording sheet through one time sheet transferring process.

However, these apparatuses capable of double-side reading and double-side recording do not collate a stack of recording sheets, particularly when a plurality of ejection trays are used, in addition to common problems of low stability in sheet transfer and of a larger machine size.

SUMMARY OF THE INVENTION

The present invention provides a novel image forming apparatus. In one example, a novel image forming apparatus includes a first image carrying member, a second image carrying member, a plurality of ejection trays, and a sheet transferring mechanism. The first image carrying member carries images in increasing order of corresponding sheet numbers. The second image carrying member carries an image transferred from the first image carrying member. The plurality of ejection trays includes a first ejection tray configured to stack a plurality of output sheets in a straight orientation and a second ejection tray configured to stack a plurality of output sheets in

a reversed orientation. The sheet transferring mechanism transfers a recording sheet to a nip formed between the first and second image carrying members. In this image forming apparatus, the first image carrying member is caused to transfer an image to one surface of the recording sheet and, at the same time, the second image carrying member is caused to transfer another image to another surface of the recording sheet in response to a selection between the first and second ejection trays in a double-side recording mode so that the first and second ejection trays stack the plurality of recording sheets in increasing order of pages.

The above-mentioned image forming apparatus may further include a mode selecting mechanism configured to select one of a single-side recording mode and the double-side recording mode.

The above-mentioned image forming apparatus may further include a tray selecting mechanism configured to select one of the first and second ejection trays.

The above-mentioned image forming apparatus may further include a sheet selecting mechanism configured to select a type of sheet. In this case, one of the first and second ejection trays is selected in accordance with a selection made by the sheet selecting mechanism.

The above-mentioned image forming apparatus may further include a plurality of sheet supplying mechanism each configured to supply the recording sheets to the sheet transferring mechanism.

The above-mentioned image forming apparatus may further include a cassette selecting mechanism configured to select one of the plurality of sheet supplying mechanism.

The above-mentioned image forming apparatus may further include a sheet

selecting mechanism configured to select a type of sheet. In this case, one of the plurality of sheet supplying mechanism is selected in accordance with a selection made by the sheet selecting mechanism.

The above-mentioned image forming apparatus may further include an extra sheet supplying mechanism configured to insert a recording sheet in an approximately straight orientation. In this case, a recording sheet is transferred from the extra sheet supplying mechanism to the first ejection tray via the sheet transferring mechanism.

The above-mentioned image forming apparatus may further include a sheet selecting mechanism configured to select a type of sheet. In this case, the extra sheet supplying mechanism and the first ejection tray are selected when the sheet selecting mechanism selects a thick sheet.

The extra sheet supplying mechanism may include a manual sheet insertion tray.

The above-mentioned image forming apparatus may further include a sensor for detecting an event in that the manual sheet insertion tray is accessed by a user. In this case, the extra sheet supplying mechanism and the first ejection tray are selected when the sheet sensor detects the event.

The first image carrying member may be caused to transfer an image of odd page to an upper surface of the recording sheet and, at the same time, the second ejection tray is caused to transfer an image of even page on a lower surface of the recording sheet when the second ejection tray is selected in a double-side recording mode so that the second ejection tray stacks a plurality of the recording sheets in increasing order of pages.

The first image carrying member may be caused to transfer an image to on one

surface of the recording sheet and the second image carrying member is caused to transfer another image on another surface of the recording sheet in response to a selection made by the tray selecting mechanism between the first and second ejection trays.

The mode selecting mechanism, the tray selecting mechanism, the sheet selecting mechanism, and the cassette selecting mechanism may be mounted on a control panel of the apparatus.

In the above-mentioned image forming apparatus, selections of a single-side recording mode and the double-side recording mode, the first and second ejection trays, and a type of sheet may be made from an external host system.

In the above-mentioned image forming apparatus, a selection of the plurality of sheet supplying mechanisms may be made from an external host system.

The first image carrying member may have a property of photoconductivity and carries a toner image made in accordance with an electrophotographic method and the second image carrying member carries a toner image transferred from the first image carrying member.

The present invention further provides another novel image forming apparatus. In one example, a novel image forming apparatus includes an image reading mechanism, an image forming mechanism, a plurality of ejection trays, a plurality of sheet cassettes, and a sheet transferring mechanism. The image reading mechanism is configured to read an original. The image forming mechanism is configured to perform an image recording operation including image forming, image carrying, and image transferring processes. The sheet transferring mechanism is configured to transfer a recording sheet from one of the plurality of sheet cassettes to a nip formed between the

first and second image carrying members. In this image forming apparatus, the image forming mechanism performs an image recording operation in response to a selection between the plurality of ejection trays in accordance with images from originals read by the image reading mechanism either in a single-side or double-side recording mode so that the plurality of ejection trays stack a stack of recording sheets in increasing order of pages.

The image forming mechanism may form a toner image in accordance with an electrophotographic method. In this case, the image forming mechanism includes first and second image carrying members. The first image carrying member is configured to form a toner image and to carry it thereon in increasing order of pages starting from a first page. The second image carrying member is configured to carry the toner image transferred from the first image carrying member. The first image carrying member transfers the toner image to one side of a recording sheet and the second image carrying member transfers the toner image to the other side of the recording sheet.

The plurality of ejection trays may include a first ejection tray configured to stack a plurality of output sheets in a straight orientation and a second ejection tray configured to stack a plurality of output sheets in a reversed orientation.

The stack of recording sheets stacked in increasing order of pages may be a stack of recording sheets recorded in the single-side recording mode or in the double-side recording mode.

The image reading mechanism may read an image on a side of a single-sided original in a single-side reading mode and images on both sides of a double-sided original in a double-side reading mode.

The image forming mechanism may record images in the single-side recording

mode and outputs in increasing order of pages when the images are read in the double-side reading mode by the reading mechanism.

The image forming mechanism may record images in the double-side recording mode and outputs in increasing order of pages when the images are read in the double-side reading mode by the reading mechanism.

The image reading mechanism may read images on both sides of a double-sided original through one time sheet transferring process by moving the double-side original.

The image reading mechanism may include a first image reading unit configured to read an image of an original by moving the original and a second image reading unit configured to read an image of an original by holding the original at a predetermined position.

The second image reading unit may include a moving member that moves under a contact glass and is used as a part of the first image reading unit under a condition in that the moving member is stopped.

The second image reading unit may be usable when originals are placed on a sheet tray of the first image reading unit.

The image reading mechanism may include a sheet reversing mechanism and reads images on both sides of an original.

The image reading mechanism may include a detector for detecting an event that an image on reading is of white and cancels reading the image when the image is detected as a page of white.

In the above-mentioned image forming apparatus, one of the plurality of ejection trays may be formed in a space between the image reading mechanism and the

image forming mechanism.

The image reading mechanism may include a tray for ejecting originals. In this case, the tray has a size within a projection area of the apparatus.

In the above-mentioned image forming apparatus, a recording sheet may be transferred in an approximately straight line from one of the plurality of sheet cassettes to one of the plurality of ejection trays.

The above-mentioned one of the plurality of sheet cassettes may be a manual sheet inserting tray.

The above-mentioned image forming apparatus may further include a control panel close to the image reading mechanism. The above-mentioned control panel includes a selecting mechanism configured to select one of the single-side recording and the double-side recording and a selecting mechanism configured to select one of the plurality of ejection trays.

The image forming mechanism may form images in increasing order of corresponding sheet numbers.

The image forming mechanism may form a plurality of images in increasing order of pages when the image reading mechanism reads the plurality of images in increasing order of pages.

The first image carrying member may have a property of photoconductivity and the second image carrying member may be a belt-shaped intermediate transfer member having a surface resistance in a range of from 10^5 to 10^{12}.

The above-mentioned image forming apparatus may further include a fixing mechanism configured to fix images attached on both sides of a recording sheet while the recording sheet is supported by the belt-shaped intermediate transfer member.

The belt-shaped intermediate transfer member may be of heat resistance.

The image forming mechanism may perform the image recording operation in accordance with image information sent from an external host system. One of the single-side recording mode and the double-side recording mode may be selected by the external host system. One of the plurality of ejection trays may be selected by the external host system.

The above-mentioned image forming apparatus may further include an external ejection tray unit that includes a connecting sheet path connected to a sheet path of the apparatus for turning and ejecting a recording sheet sent from the image forming mechanism into one of the plurality of ejection trays. In this case, the external ejection tray unit stacks a plurality of recording sheet in increasing order of pages.

The connecting sheet path may be arranged along an edge portion of the one of the plurality of ejection trays.

The above-mentioned image forming apparatus may further include a switching pawl configured to selectively switch between ways for a recording sheet to the one of the plurality of ejection trays and the external ejection tray unit.

The above-mentioned image forming apparatus may further include another external ejection tray unit that includes a connecting sheet path connected to a sheet path of the apparatus for ejecting a recording sheet sent from the image forming mechanism in an approximately straight manner into one of the plurality of ejection trays. In this case, the external ejection tray unit stacks a plurality of recording sheet in increasing order of pages.

The present invention provides a novel method for image forming. In one example, a novel method includes the steps of selecting, choosing, inputting,

performing, repeating, executing, and repeating. The selecting step selects one of a single-side recording and a double-side recording. The choosing step chooses one of a face-down stack and a face-up stack. The inputting step inputs a plurality of images in increasing order of pages. The performing step performs a double-side recording operation when the double-side recording is selected. The performing step includes the steps of forming, transferring, fixing, and stacking. The forming step forms two successive images in increasing order of corresponding sheet numbers. The transferring step transfers the two successive images onto both surfaces of a recording sheet. The fixing step fixes the two successive images attached on the both surfaces of the recording sheet. The stacking step stacks the recording sheet in an orientation in accordance with a choice chosen by the choosing step. The repeating step repeats the performing step until the images input by the inputting step are recorded. The executing step executes a single-side recording operation when the single-side recording is selected. The executing step includes the steps of forming, transferring, fixing, and stacking. The forming step forms an images in increasing order of corresponding sheet numbers. The transferring step transfers the image onto one surface of a recording sheet. The fixing step fixes the image attached on the on surface of the recording sheet. The stacking step stacks the recording sheet in an orientation in accordance with a choice chosen by the choosing step. The repeating step repeats the executing step until the images input by the inputting step are recorded.

The inputting step may read a plurality of originals and generates data of a plurality of images.

BRIEF DESCRIPTION OF THE DRAWING

A more complete appreciation of the present application and many of the

attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a cross-sectional view of a background image forming apparatus;

Fig. 2 is a cross-sectional view of a printer according to an embodiment of the present invention;

Fig. 3 is an illustration for explaining a control panel of the printer of Fig. 2;

Fig. 4 is a cross-sectional view of a color printer according to the embodiment of the present invention;

Fig. 5 is a cross-sectional view of an image forming apparatus, including the printer of Fig. 2, a scanner, and an automatic document feeder (ADF);

Fig. 6 is a perspective view of the image forming apparatus of Fig. 5;

Fig. 7 is a cross-sectional view of an image sensor included in the ADF of Fig. 5;

Fig. 8 is a cross-sectional view of an image forming apparatus of Fig. 5 without the ADF;

Fig. 9 is a table for explaining relationships between various manners of image reading and various manners of image forming performed by the image forming apparatuses of Figs. 5 and 8;

Fig. 10 is a cross-sectional view of the image forming apparatus of Fig. 5 with extra ejection trays;

Fig. 11 is a cross-sectional view of an image forming apparatus including a modified printer, a modified scanner, and a modified automatic document feeder (ADF) according to another embodiment of the present invention; and

Fig. 12 is a cross-sectional view of a color image forming apparatus including the color printer of Fig. 4, the scanner of Fig. 5 and the ADF of Fig.5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing preferred embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the invention is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents which operate in a similar manner.

Referring now to the drawings, wherein like reference numeral designate identical or corresponding parts throughout the several views, particularly to Fig. 2, a printer 100 according to an embodiment of the present invention is described. As shown in Fig. 1, the printer 100 is provided at its approximate center with a photoconductive drum 1 serving as a first image carrying member. Around the photoconductive drum 1, the printer 100 is further provided with various components including a cleaning unit 2, a cleaning unit 2, a discharging unit 3, a charging unit 4, and a development unit 5. Above, the photoconductive drum 1, an exposure unit 7 is provided which emits a laser beam L in a direction between the charging unit 4 and the development unit 5 to impinge on the surface of the photoconductive drum 1 at a writing position.

In the printer 100, the photoconductive drum 1, the cleaning unit 2, the discharging unit 3, the charging unit 4, and the development unit 5 are assembled into a single unit (hereinafter referred to as a process cartridge) which can be exchanged at a time when it consumes its lifetime, for example.

The printer 100 is further provided with a belt unit 20 under the

photoconductive drum 1. The belt unit 20 includes an intermediate transfer belt 10, serving as a second image carrying member, to which the photoconductive drum 1 contacts. The intermediate transfer belt 10 is extended under pressure between rollers 11, 12, and 13 and is rotated counterclockwise. The intermediate transfer belt 10 has a property of electric resistance by which toner can be transferred, and also has a property of heat resistance. In this example, the intermediate transfer belt 10 has a surface resistance in a range of from $10^5 f\P$ to $10^{12} f\P$.

The intermediate transfer belt 10 is provided inside with rollers 14 and 15 for supporting the intermediate transfer belt 10, cooling rollers 16 for cooling it, a lower fixing roller 18, and a first transfer mechanism 21. The lower fixing roller 18 includes a heat source such as a heater and fixes a toner image, transferred onto a first surface of a recording sheet, on the same first surface of the recording sheet. The first transfer mechanism 21 is arranged at a position opposite to the photoconductive drum 1 relative to the intermediate transfer belt 10 so as to transfer a toner image formed on the photoconductive drum 1 onto the intermediate transfer belt 10 or a first surface of a recording sheet.

A second transfer mechanism 22, a fixing unit 30, and a belt cleaning unit 25 are arranged around the intermediate transfer belt 10. The fixing unit 30 includes an upper fixing roller 19 having inside a heat source such as a heater and fixes a toner image, transferred onto a second surface of a recording sheet, to the same second surface of the recording sheet. The fixing unit 30 is held such as to be moved about a fulcrum 30a. Thus, the fixing unit 30 can be tilted back and forth in directions G with a mechanism (not shown) so as to contact under pressure and move away from the lower fixing roller 18. Ventilation inside the printer 100 is performed by fan F1 which is

provided at a position left and above the fixing unit 30.

The belt cleaning unit 25 is provided inside with a cleaning roller 25a, a cleaning blade 25b, a toner transfer mechanism 25c, and a pivot shaft 25d so as to clean residual toner off the surface of the intermediate transfer belt 10. The residual toner accumulated in the belt cleaning unit 25 is transferred with the toner transfer mechanism 25c to a toner collection container (not shown). The belt cleaning unit 25 is tilted about the pivot shaft 25d back and forth in directions H with a mechanism (not shown) so as to contact and move away from the intermediate transfer belt 10.

A sheet cassette 26 that contains a plurality of recording sheets P is provided at a lower part of the printer 100 and is configured to be pulled from the printer 100 in a right direction in Fig. 2. A sheet feed roller 27 is provided at a position close to and above the leading edge of the sheet cassette 26 in a sheet transfer direction, i.e., a right direction in Fig. 2. A pair of registration rollers 28 are arranged at a position right to the photoconductive drum 1 and a guide member 29 is provided to guide a recording sheet to a transfer position from the registration rollers 28. Above the sheet cassette 26, an electric unit E1 and a control unit E2 are arranged. A manual sheet inlet 35 that includes a plate 37 on which a plurality of recording sheets P are placed is provided to a right side of the printer 100 and a sheet feed roller 36 is arranged at a position such as to feed a recording sheet placed on the plate 37. A recording sheet inserted from the manual sheet inlet 35 is guided to the registration rollers 28 by the guide member 29.

A switching pawl 42 is provided at a position left to the fixing unit 30. The switching pawl 42 is turned about a pivot 43 with an actuator (not shown), i.e., a solenoid, to switch a transfer direction of the recording sheet P sent from the belt unit 20 to a stacking portion 40 formed on the upper surface of the printer 100 or to an ejection

tray 44 provided to a left side of the printer 100. The recording sheet is sent to the stacker 40 when the switching pawl 42 is set at a position, as shown in Fig. 2, and is sent to the ejection tray 44 when the switching pawl 42 is turned in a direction J.

A pair of transfer rollers 33 for transferring the recording sheet P are provided above the switching pawl 42 and a pair of ejection rollers 34 for ejecting the recording sheet P to the stacker 40 are provided above the transfer rollers 33. Guide members 31a and 31b are arranged between the transfer rollers 33 and the ejection rollers 34. A pair of ejection rollers 32 for ejecting the recording sheet P to the ejection tray 44 are arranged at a position left to the switching pawl 42.

The printer 100 of Fig. 2 structured in the above-described way performs an image forming operation in which images are recorded on both surfaces of a recording sheet, in the following manner. In this discussion, an image to be first formed is referred to as a first image and an image to be next formed is referred to as a second image. Further, a surface of the recording sheet P on which a first image is printed is referred to as a first surface of the recording sheet P and the other surface on which a second image is printed is referred to as a second surface of the recording sheet P.

The printer 100 receives signals from an external host system (not shown), i.e., a computer, and forms images with the exposure unit 7 in accordance with the signals. Light from a laser light source of the exposure unit 7 is continuously reflected by a motor-driven rotary polygonal mirror 7a and, via mirrors 7b and an f-*f*Æ lens, impinges on the charged surface of the photoconductive drum 1. Thereby, an electrostatic latent image is formed on the photoconductive drum 1 in accordance with the received signals.

The above electrostatic latent image is developed with toner by the development unit 5 into a visual toner image and is held on the photoconductive drum 1.

For the convenience sake, this toner image is referred to as the first toner image. The first toner image is then transferred by an action of the first transfer mechanism 21 onto the intermediate transfer belt 10 which is rotated in synchronism with the photoconductive drum 1. After the transfer process, the toner remaining on the surface of the photoconductive drum 1 is removed by the cleaning unit 2 and the charge thereon is discharged by the discharging unit 3. The photoconductive drum 1 is thus prepared for a next job cycle of image forming.

The intermediate transfer belt 10 is rotated counterclockwise, as shown in Fig. 2, while carrying the first toner image which is to be transferred onto a first surface of the recording sheet P. During this process, the second transfer mechanism 22, the fixing unit 30, and the belt cleaning unit 25 are controlled to keep in an inoperable position, that is, electric inputs to these components are cut off or these components are moved away from the intermediate transfer belt 10.

A process for forming a second toner image in a like manner as described above on the photoconductive drum 1 is started when the intermediate transfer belt 10 carrying the first toner image is advanced to a predetermined position. At the same time, the recording sheet P is started to be transferred from the sheet cassette 26 or from the manual sheet inlet 35. When the sheet feed roller 27 or 36 is rotated in a direction indicated by an arrow in Fig. 2, an uppermost recording sheet P is transferred towards the registration rollers 28.

As the intermediate transfer belt 10 moved in synchronism with the photoconductive drum 1 is rotated, the first toner image carried on the intermediate transfer belt 10 is advanced to a position where the intermediate transfer belt 10 contacts the photoconductive drum 1.

The recording sheet P is advanced by the registration rollers 28 to a contact position between the photoconductive drum 1 and the intermediate transfer belt 10 such that the second surface of the recording sheet P contacts the surface of the photoconductive drum 1. Then, the second toner image formed on the photoconductive drum 1 is transferred onto the second surface of the recording sheet P by the first transfer mechanism 21. During this process, the recording sheet P is transferred by the registration rollers 28 such that the second toner image is transferred onto a proper position in the second surface of the recording sheet P.

During a time when the second toner image is transferred from the photoconductive drum 1 to the second surface of the recording sheet, the first surface of the recording sheet P contacts the surface of the intermediate transfer belt 10 on which the first toner image is carried. When the recording sheet P passes through a transfer region of the second transfer mechanism 22, a voltage is applied to the second transfer mechanism so that the first toner image is transferred onto the first surface of the recording sheet P.

Thus, the first and second images are attached on the first and second surfaces, respectively, of the recording sheet P. The recording sheet P is further transported to a fixing region of the fixing unit 30 by the intermediate transfer belt 10. The fixing unit 30 is moved such that the upper fixing roller 19 presses the lower fixing roller 18 via the intermediate transfer belt 10. Thereby, the first and second toner images are fixed to the first and second surfaces, respectively, at the same time. After the transfer process, the recording sheet P is kept in contact with the intermediate transfer belt 10 and therefore the toner images are kept in desirable conditions without wobbling.

After the fixing process, the recording sheet P is separated from the

intermediate transfer belt 10 at the roller 11 due to a relationship between a stiffness of the recording sheet P and a curvature of the roller 11. The recording sheet P is further transferred to either the stacker 40 or the ejection tray 44 depending upon the position of the switching pawl 42.

When the recording sheet P is output to the stacker 40, the first surface of the recording sheet P faces down in the stacker 40. Therefore, when stacking in page order is desired, the second toner image is needed to be firstly generated and retained on the intermediate transfer belt 10 and the first toner image generated afterwards is transferred onto the recording sheet P directly from the photoconductive drum 1. More specifically, the first toner image is to be recorded on the second page and the second toner image is to be recorded on the first page of the recording sheet P. For the third page and onwards, this sequential order is needed to be maintained in the same manner. That is, when an even page has an image, this image is first generated and preserved on the intermediate transfer belt 10 and an image of the following odd page is then generated so as to be transferred from the photoconductive drum 1 to the recording sheet P. In this case, the sequential order of the image forming in page numbers is as follows;

2 _¨ 1 _¨ 4 _¨ 3 _¨ 6 _¨ 5 _¨ _E_E_E_E.

In addition, the output order of the recording sheets P in sheet numbers is expressed as;

1st sheet _¨ 2nd sheet _¨ 3rd sheet _¨ _E_E_E_E.

That is, the image forming is performed in increasing order of sheet numbers. The first and second pages are recorded on the first sheet, the third and fourth pages are recorded on the second sheet, the fifth and sixth pages are recorded on the third sheet, and so on, for example.

Some other image forming apparatuses performs the image forming in a

reverse order, that is, images of the last page and one before the last pages are recorded on a sheet first output. This sheet may be referred to as the first sheet in relation to these apparatuses. However, in the printer 100, the first sheet in a double-side recording is defined as a sheet on which images of the first and second pages are recorded, but not as a sheet which is first output. In a single-side recording, the first sheet is defined as a sheet on which the first page is recorded. The term double-side recording means a recording mode in which recording is performed on both sides of a recording sheet. The term single-side recording means a recording mode in which recording is preformed on a single side of a recording sheet.

When the recording sheet P is ejected to the ejection tray 44, the second surface having the second toner image from the photoconductive drum 1 faces up. Therefore, when stacking in page order is desired in the ejection tray 44, the first toner image is needed to be firstly generated and retained on the intermediate transfer belt 10 and the second toner image generated afterwards is transferred onto the recording sheet P directly from the photoconductive drum 1. It is needed to be arranged that the first toner image is recorded on the first page and the second toner image is recorded on the second page of the recording sheet P. This sequential order is maintained in the same manner for the third page and onwards. That is, when an odd page has an image, this image is first generated and preserved on the intermediate transfer belt 10 and an image of the following even page is then generated so as to be transferred from the photoconductive drum 1 to the recording sheet P. In this case, the sequential order of the image forming in page numbers is as follows;

1 _¨ 2 _¨ 3 _¨ 4 _¨ 5 _¨ 6 _¨ _E_E_E_E.

In addition, an output order of the recording sheets P in sheet numbers is expressed as;

1st sheet _" 2nd sheet _" 3rd sheet _" _E_E_E_E.

That is, the image forming is performed in increasing order of sheet numbers, as is the case with the stacking in the stacker 40.

In any case, either stacking in the stacker 40 or in the ejection tray 44, the image forming is performed in increasing order of sheet numbers so that the user can easily find a sheet to see. In many cases, the user may instantly check if the image forming is performed in a manner desired by the user by seeing, particularly, the first page or first few pages. When the image forming is performed in decreasing order of sheet numbers, that is, the last sheet having the last page is first output, the user needs to wait until the first sheet having the first page is output.

In addition, the image forming performed in increasing order of sheet numbers facilitates handling of the sheets at an occurrence of a paper jam in the printer 100. After eliminating conditions of the paper jam, the user simply needs to instruct the printer 100 to start the image forming from the page included in the jammed sheet. This kind of paper jam handling would help the user, particularly, when the printer 100 is in a mode in which the process of eliminating an error condition by the paper jam is not automated and the user is required to cope with the problem.

In the printer 100, the user can select in the double-side recording mode either the stacker 40 or the ejection tray 44 through a control panel 50 (Fig. 3), explained later. When the user select in the double-side recording mode either one of the stacker 40 and the ejection tray 44, the image forming is controlled to be performed in the above-described sequence so that the recording sheets are ejected to the designated place in increasing order of sheet numbers. Controlling the order of the image forming according to the order of sheet numbers is performed by a control unit, which is not

shown.

Accordingly, the user simply needs to select one of the stacker 40 and the ejection tray 44 without paying attention to a relationship between the order of sheet numbers and the order of the image forming. Thus, the printer 100 can perform the double-side recording without requiring the user to perform complex operations. The order of the image forming can be switched from one to another with a known technique associated with storage of image data into a memory.

In the printer 100, when the recording sheet is transferred from the manual sheet inlet 35 to the ejection tray 44, a passage of the recording sheet is approximately straight. Therefore, a thick sheet including a thick paper sheet, an overhead-projector sheet, etc., is preferably inserted in the manual sheet inlet 35 and is ejected to the ejection tray 44 through the straight passage. Thus, the thick sheets can be processed in the double-side recording and be output in the appropriate page order, without causing problems in running through the passage.

As for a standard sheet, it can be sent from either the sheet cassette 26 or the manual sheet inlet 35 and be ejected to either the stacker 40 or the ejection tray 44. In this case, the sheets can be output in the double-side recorded mode in the appropriate page order. This sequence may be set as a default since the standard sheet is normally a frequently used sheet.

In a typical image forming, a mirror image is formed on the photoconductive drum 1 and is directly transferred onto the recording sheet P, thereby turning into a normal image. However, when the intermediate transfer belt 10 is involved, that is, the mirror image on the photoconductive drum 1 is transferred to the intermediate transfer belt 10 and is transferred to the recording sheet P, the mirror image is formed on the

recording sheet P. Therefore, a normal image is formed on the photoconductive drum 1 for the first surface of the recording sheet P and a mirror image is formed on the photoconductive drum 1 for the second surface of the recording sheet P. This image alternation in a normal or mirror mode can be performed by controlling the exposure unit 7 using a known image processing technique.

The belt cleaning unit 25 separated away from the intermediate transfer belt 10 is turned after the toner image is transferred onto the recording sheet P from the intermediate transfer belt 10 such that the cleaning roller 25a contacts the intermediate transfer belt 10. Thereby, the residual toner is removed from the intermediate transfer belt 10 to the cleaning roller 25a and is scraped off the cleaning roller 25a by the cleaning blade 25b. The scraped toner is collected by the toner return mechanism 25c to the toner collection container (not shown). The residual toner applied with heat by the lower and upper fixing rollers 18 and 19 is prone to be removed from the intermediate transfer belt 10 before it is cooled. Therefore, the belt cleaning unit 25 is preferably arranged upstream from the cooling rollers 16.

After the cleaning process, the intermediate transfer belt 10 passes through the cooling region where the cooling rollers 16 cool the intermediate transfer belt 10. As an alternative to the cooling rollers 16, a heat pipe may be arranged to contact the inside surface of the intermediate transfer belt 10 or an application of an air flow to the intermediate transfer belt 10 after the fixing process may also be effective.

Next, procedures of the single-side recording in the printer 100 are explained. A procedure of the single-side recording using the stacker 40 is different from that using the ejection tray 44. When the recording sheets P are output into the stacker 40, the process of transferring the toner image onto the intermediate transfer belt 10 is

eliminated and the toner image formed on the photoconductive drum 1 is directly transferred onto the recording sheet P. In this case, the toner image on the photoconductive drum 1 is a mirror image and is transferred onto the recording sheet P in a form of a normal image.

In Fig. 2, the recording sheet P is fed to the contact position between the photoconductive drum 1 and the intermediate transfer belt 10 in synchronism with the movement of the toner image on the photoconductive drum 1 and the toner image is transferred onto the upper surface of the recording sheet P facing the photoconductive drum 1 by the action of the first transfer mechanism 21.

In this procedure, the second transfer mechanism 22 is not operated. The recording sheet P is moved with the intermediate transfer belt 10 and the toner image is fixed on the recording sheet P through the fixing unit 30. After that, the recording sheet P is separated away from the intermediate transfer belt 10 and is lifted upward along the switching pawl 42, the guide members 31a and 31b, the transfer rollers 33, and the ejection rollers 34. Then, the recording sheet P is ejected in the direction A1 so as to be ejected face down in the stacker 40. As a result, a plurality of the recording sheets P are stacked face down in increasing number of sheet numbers. That is, although the image forming is performed in increasing order of page numbers from the first page, the user can have the plurality of the recording sheet P in increasing order of page numbers with the first page on its top when removing the stack of the recording sheets P from the stacker 40. With this configuration, the sequential order of the image forming in page numbers is as follows;

1 _ " 2 _ " 3 _ " 4 _ " 5 _ " 6 _ " _E_E_E_E.

In addition, the output order of the recording sheets P in sheet numbers in this case is

expressed as;

1st sheet _¨ 2nd sheet _¨ 3rd sheet _¨ _E_E_E_E.

When the ejection tray 44 is used to stack the recording sheets P, the toner image formed on the photoconductive drum 1 is transferred onto the intermediate transfer belt 10 with the first transfer mechanism 21 and is turned with the rotation of the intermediate transfer belt. The recording sheet P is fed to the contact position between the photoconductive drum 1 and the intermediate transfer belt 10 in synchronism with the movement of the toner image on the intermediate transfer belt 10. Then, the toner image on the intermediate transfer belt 10 is transferred onto the lower surface of the recording sheet P by the second transfer mechanism 22. After that, the recording sheet P is separated away from the intermediate transfer belt 10 and is straightly transferred via the switching pawl 42 in the direction A2 so as to be ejected face down in the ejection tray 44. As a result, a plurality of the recording sheets P are stacked face down in increasing number of sheet numbers. That is, although the image forming is performed in increasing order of page numbers from the first page, the user can have the plurality of the recording sheet P in increasing order of page numbers with the first page on its top when removing the stack of the recording sheets P from the ejection tray 44. With this configuration, the sequential order of the image forming in page numbers is as follows;

1 _¨ 2 _¨ 3 _¨ 4 _¨ 5 _¨ 6 _¨ _E_E_E_E.

In addition, the output order of the recording sheets P in sheet numbers is expressed as;

1st sheet _¨ 2nd sheet _¨ 3rd sheet _¨ _E_E_E_E.

As described above, in the single-side recording, the same order of the image forming in page numbers is applied to both cases of using the stacker 40 and the ejection

tray 44 and a difference between the two cases is that the toner image is transferred onto the upper surface or the lower surface of the recording sheet P.

In the printer 100, the user can select in the single-side recording mode either the stacker 40 or the ejection tray 44 through the control panel 50 (Fig. 3), explained later. When the user select in the single-side recording mode either one of the stacker 40 and the ejection tray 44, the image forming is controlled to be performed in the above-described sequence so that the recording sheets P are ejected to the designated place in increasing order of sheet numbers. Accordingly, the user simply needs to select one of the stacker 40 and the ejection tray 44 without paying attention to a relationship between the order of sheet numbers and the order of the image forming. Thus, the printer 100 can perform the double-side recording without requiring the user to perform complex operations.

In the single-side recording mode, a thick sheet including a thick paper sheet, an overhead-projector sheet, etc., is preferably inserted in the manual sheet inlet 35 and is ejected to the ejection tray 44 through the straight passage. Thus, the thick sheets can also be processed in the single-side recording and be output in the appropriate page order, without causing problems in running through the passage.

As described above, in the printer 100, the recording sheets P are output in the increasing order of sheet numbers such as the first page, the second page, the third page, and so on in both cases of the single-side and double-side recordings, regardless of whether the stacker 40 or the ejection tray 44 is selected. Therefore, in both cases, the user can easily check if the image forming is performed in a desired manner. In addition, in both cases, the user can easily instruct the printer 100 to restart the image forming operation upon occurrence of an error of the paper jam.

Fig. 3 shows the control panel 50 provided to the printer 100. As shown in Fig. 3, the control panel 50 includes a LCD (liquid crystal display) 51 and various function buttons. Among the various function buttons, an online button 52 switches the condition of the printer 100 between online and offline. A reset button 53 resets the present conditions to default conditions. A sheet selection button 54 designates a type of the recording sheet P. For example, when an extraordinary type of sheet such as a thick sheet is used, the sheet selection button 54 is pressed to allow selection of such sheet. A double-side recording button 55 makes the double-side recording mode effective. An input enabling button 56 enables various inputs. By pressing the input enabling button 56, various items can be displayed on the LCD 51. To find and select a desired item, an up-scrolling button 58 having a black triangle mark scrolls upwards the items displayed on the LCD 51 and a down-scrolling button 59 having a black reversed triangle mark scrolls the items downwards. An execution button 57 executes the designation of the selected item. The input enabling button 56 covers the items of selecting the sheet feed unit (i.e., the sheet cassette 26 or the manual sheet inlet 35) and of selecting the output tray (i.e., the stacker 40 or the ejection tray 44).

In the printer 100, the double-side recording mode is selected by a press of the double-side recording button 55. During this selection, selection of the sheet cassette 26 and the manual sheet inlet 35 and selection of the stacker 40 and the ejection tray 44 can be performed with the input enabling button 56. This selection may also be performed in a combination of the sheet feed unit and the output tray. In the single-side recording mode, selections of the sheet feed unit and the output tray are allowed.

With the above-described structure, the printer 100 can feed the recording sheets P from the designated sheet feed unit and output the recording sheets P to the

designated output tray in an appropriate page order in both the single-side recording and the double-side recording by properly designating the sheet feed unit and the output tray. Thus, the user can obtain the outputs in the page order without paying attention to the order of the image forming relative to the sheet order.

As described above, when a thick sheet including a thick paper sheet, an OHP sheet, and so on is used, such a sheet is preferably inserted from the manual sheet inlet 35 and is ejected to the ejection tray 44 so as to run along a straight passage. In the printer 100, the manual sheet inlet 35 and the ejection tray 44 are automatically selected when a thick sheet is selected with the sheet selection button 54. Accordingly, when the user desires outputs in page order using a thick sheet in either the single-side recording or the double-side recording, the user needs to select the thick sheet using the sheet selection button 54 without paying attention to the selections of the sheet feed unit and the output tray and to the order of the image forming relative to the sheet numbers.

In the printer 100, the stacker 40 is designated as a regular sheet feed unit in both the single-side recording and the double-side recording when a regular sheet is selected to be used so that the recording sheets P are stacked in an appropriate page order in the stacker 40 where the user can easily take out the stack of the recording sheets P.

In this way, the output tray is automatically designated in accordance with the selection of the sheet type and the order of the image forming is controlled such that the recording sheets P are ejected to the designated output tray in the page order. Thus, the user can obtain the stack of the recording sheets P in the page order by simply selecting the type of the recording sheet P.

As shown in Fig. 2, the printer 100 is provided with a sensor 38 at a position

inside the printer 100 and close to the manual sheet inlet 35. The sensor 38 detects a condition of the manual sheet inlet 35 whether it is closed or open. When the sensor 38 detects that the manual sheet inlet 35 is open, the printer 100 automatically selects the thick sheet mode and the ejection tray 44.

With this configuration, the user can simply place the recording sheets to the manual sheet inlet 35 by opening it when using the thick sheets, thereby obtaining the stack of the recording sheets P in an appropriate page order in the ejection tray 44 in both the single-side recording or the double-side recording.

In the printer 100, the switching of the sheet ejection passage is achieved by a simple mechanism using a single component such as a switching pawl 42, as described above.

In addition, the printer 100 allows the selections of various operation conditions from an external host system connected to the printer 100 as well as through the control panel 50, as described above. Accordingly, the user of the external host system can remotely select the sheet feed unit, the output tray, the sheet type, and so on.

Next, a color printer 100B according to the embodiment of the present invention is explained with reference to Fig. 4. The color printer 100B is similar to the printer 100 of Fig. 2, except for a revolver type development unit 5R and a mechanism for moving the intermediate transfer belt 10 to separate it away from the photoconductive drum 1. Components having the same functions as those in the printer 100 are labeled with the same references and the following discussions focus to the difference between the two printers.

As shown in Fig. 4, the revolver type development unit 5R is rotatable and includes development stations 5a - 5d. The revolver type development unit 5R is

rotated so as to switch the development stations 5a – 5d from one to another to locate at a development position. The development stations 5a – 5d contain color toners that enable a full color development. For example, the development stations 5a, 5b, 5c, and 5d contain yellow, magenta, cyan, and black toner, respectively. To form a monochrome toner image, the development station 5d is moved to locate at the development position and the image forming in the page order is performed in a manner similar to that performed by the printer 100 of Fig. 2.

To form a full color image, the exposure unit 7 is caused to generate light information to be developed with the yellow toner and to scan the charged surface of the photoconductive drum 1 with the light information so as to form an electrostatic latent image, while the intermediate transfer belt 10 is separated away from the photoconductive drum 1. The development station 5a is moved to the development position and is activated to develop the electrostatic latent image with the yellow toner. Likewise, a magenta toner image is formed on the photoconductive drum 1 overlaying the yellow toner image. After that, a cyan toner image is generated to further overlay the yellow and the magenta toner images. Finally, a black toner image is formed and overlay the yellow, magenta, and cyan toner images on the photoconductive drum 1. Thereby, a four color toner image is formed on the surface of the photoconductive drum 1 which is rotated four times during the generation of the four color toner image.

After a completion of the four color toner image, the intermediate transfer belt 10 is moved to contact the photoconductive drum 1. At the same time, the recording sheet P is transferred, in synchronism with the movement of the four color toner image, to the contact position between the photoconductive drum 1 and the intermediate transfer belt 10. The four color toner image is then transferred onto the recording sheet

P by the action of the first transfer mechanism 21.

In the double-side recording, the intermediate transfer belt 10 is moved to contact the photoconductive drum 1 when the first toner image is formed on the photoconductive drum 1 so that the first toner image is transferred onto the intermediate transfer belt 10 by the first transfer mechanism 21. The intermediate transfer belt 10 is then moved away from the photoconductive drum 1 and is brought into a standby mode. After that, the second toner image, i.e., the second four color toner image, is formed on the photoconductive drum 1. When the second toner image is formed on the photoconductive drum 1, the intermediate transfer belt 10 is controlled to start running such that the leading edge of the second toner image on the photoconductive drum 1 meets the leading edge of the first toner image on the intermediate transfer belt 10. The intermediate transfer belt 10 is moved to contact the photoconductive drum 1 and the recording sheet P is fed to the contact position between the photoconductive drum 1 and the intermediate transfer belt 10 in synchronism with the movement of the second toner image on the photoconductive drum 1. The second toner image on the photoconductive drum 1 is transferred onto the second surface of the recording sheet P by the action of the first transfer mechanism 21 and the first toner image on the intermediate transfer belt 10 is transferred onto the first surface of the recording sheet P by the action of the second transfer mechanism 22. Thus, the first and second toner images are transferred onto the first and second surfaces of the recording sheet P. The recording sheet P is further transported in a close contact with the intermediate transfer belt 10 to the fixing unit 30. In both single-side and double-side recording modes, processes after the fixing unit are similar to those described in the operation of the printer 100.

As in the case of the printer 100, the toner image generations are executed in an

increasing order of page numbers and the recording sheets P are output in an increasing order of sheet numbers in both single-side and double-side recordings in the color printer 100B, regardless of which output tray is selected. Therefore, the user can easily check whether the images are generated in a desired form and can easily handle the error conditions caused by the paper jam.

As an alternative to the revolving type development unit 5R, the color printer 100B may include a tandem type development unit while performing the same function as described above. In this case, a photoconductive belt is used in place of the photoconductive drum 1 and a plurality of development stations included in the tandem type development unit are arranged along the photoconductive belt.

Next, an image forming apparatus according to the present invention is explained with reference to Figs. 5 - 7. The image forming apparatus of Fig. 5 includes the printer 100 of Fig. 2 and a scanner 200. The scanner 200 is provided on the top thereof with an ADF (automatic document feeder) 250, as shown in Fig. 5. The ADF 250 automatically feeds a sheet-formed original S which is placed on the ADF 250. The image forming apparatus of Fig. 5 can perform various functions including copying the image of an original, transmitting the image of the original through a facsimile procedure, outputting data on a sheet in accordance with signals sent from an external computer, and so on. Fig. 6 shows an external view of the image forming apparatus of Fig. 5. As shown in Fig. 6, the sheet cassette 26 is capable of being pulled out in a direction indicated by an arrow C. An upper part of the printer 100 serves as the stacker 40.

The scanner 200 is capable of performing a sheet scanning in which an original is read while it is moved and a book scanning in which an original is read by a moving

member. In the scanner 200, contact glasses 62 and 63 are arranged on an upper part of a frame 61. The contact glass 62 is greater than the contact glass 63 and is used as a plate on which an original is placed and is read in the book scanning mode. The contact glass 63 is used when an original is read as it is transferred by the SDF 250 in the sheet scanning mode.

Inside the scanner 200, a first moving member 65 including a light source 64 and mirrors and a second moving member 66 including mirrors are arranged so as to slide in parallel to the contact glass 62. The scanner 200 employs a known optical system in which the first moving member 65 is moved at a half-speed of the second moving member 66. In the book scanning mode, an original is read while the first and second moving members 65 and 66 are moved. In the sheet scanning mode, the first and second moving members 65 and 66 are stopped at positions, as shown in Fig. 5, and the original is read at a position of the contact glass 63 as the original is moved relative to the contact glass 63.

In both sheet and book scanning modes, an original is irradiated with light of the light source 64 and an image of the original is focused on a fixed lens 67 and is captured by a CCD (charge-coupled device) 68 which then converts the captured light information into an analog signal. Based on this analog signal, digital image data is generated. After that, the digital image data is subjected to various kinds of signal processing so as to be used as facsimile information, print information to be printed on an image forming apparatus such as the printer 100, image information to be edited by a computer, and so on.

The ADF 250 includes a sheet bed 71 on which a stack of originals to be read are placed. The sheet bed 71 is provided with a moving plate 72. As shown in Fig. 5, a

sheet transfer mechanism 73 of the ADF 250 is formed in a left side portion of the sheet bed 71. The sheet transfer mechanism 73 is provided with a sheet feed roller 74 arranged at an upper top of the moving plate 72, a pair of separation rollers 75, a pair of transfer rollers 76, an image sensor 78, a transfer roller 77 arranged at a position facing the image sensor 78, a sheet pressure plate 79, a transfer roller 80, and a pair of ejection rollers 81. Under the sheet bed 71, an ejection tray 82 is arranged and a space between the sheet bed 71 and the ejection tray 82 is used as an ejection space. A pressure plate 70 is arranged under the ejection tray 82 and holds under pressure an original placed on the contact glass 62. A bottom surface of the pressure plate 70 is adhered with a white sheet 69. The upper portion of the ADF 250 including the pressure plate 70 is tilted upwards so that the contact glasses 62 and 63 are exposed. The pressure plate 70 is configured to press a thick original such as a book. It is convenient to use the ADF 250 when originals are of sheet type. The ADF 250 is detachably mounted to the image forming apparatus.

A stack of sheet originals are placed on the moving plate 72 of the sheet bed 71 with the first page up. The sheet feed roller 74 is rotated in a direction indicated by an arrow (i.e., clockwise in Fig. 5) so that the uppermost sheet in the stack of originals is transferred to the sheet transfer mechanism 73. The pair of separation rollers 75 feed the originals sheet by sheet. The original fed from the moving plate 72 is transferred through a sheet path, via the transfer rollers 76, 77, and 80, to the ejection rollers 81 and is ejected in a direction B. The original is therefore stack in the ejection tray 82 with the first page down.

During the above process, the original passes by the image sensor 78 with the second surface facing a reading part of the image sensor 78 so that the image sensor 78

reads the second page. After passing by the image sensor 78, the original passes through a space between the sheet pressure plate 79 and the contact glass 63 with the first surface facing the contact glass 63 so that the scanner 200 reads the first page of the original. When the scanner 200 reads an original passing by the contact glass 63, the first and second moving members 65 and 66 are stopped at the reading position under the contact glass 63.

Thus, when the ADF 250 is used, the first and second surfaces of an original are read at two different positions during a time of sheet transfer. Hereinafter, a reading mechanism that reads a moving original of sheet type is referred to as a first reading mechanism R1 and a reading mechanism that reads a stationary original with the moving members 65 and 66 is referred to as a second reading mechanism R2.

In Fig. 5, the first reading mechanism R1 is indicated as presenting the image sensor 78 of the ADF 250 and the second reading mechanism R2 is indicated in the middle of the scanner 200. The scanner 200 is regarded as the second reading mechanism R2 when reading a stationary original pressed by the pressure plate 70. However, the scanner 200 is regarded as a part of the first reading mechanism R1 when an original of sheet type is read while it is transferred by the ADF 250 with the moving members 65 and 66 stopped at the reading position under the contact glass 63. That is, the first reading mechanism R1 includes a part centered with the image sensor 78 of the ADF 250 and a part which is the scanner 200 with the moving members 65 and 66 stopped at the reading position under the contact glass 63.

When an original of transparent sheet is read, a color of the pressure plate may be read as a background. Therefore, the pressure plate 70 is adhered with the white sheet 69 on the surface facing the original. Likewise, the transfer roller 77 and the sheet

pressure plate 79 are colored in white.

Fig. 7 is a sectional-view of the image sensor 78. As shown in Fig. 7, the image sensor 78 includes a glass 83 facing an original, a light source 84 (i.e., an LED(light-emitting diode)) for lighting an image surface of an original, a lens array 85 for making an image in focus, and an equal magnification lens 86. A closely-contact sensor that requires no focusing lens may is substituted for the image sensor 78.

When an original of a relatively thick book is placed on the second reading mechanism R2, the thick book is pressed by the pressure plate 70 and accordingly the first reading mechanism R1 is lifted up. This leads a separation of the sheet pressure plate 79 away from the contact glass 63. For this reason, the ADF 250 is provided with a sensor (not shown) for detecting such an event in that the sheet pressure plate 79 is moved away from the contact glass 63. Based on this detection, a use of the first reading mechanism R1 is inhibited.

When an emergency job including reading and image forming occurs during a reading process of a sheet original with the first reading mechanism R1, the image forming apparatus of Fig. 5 allows an interruption due to such an emergency job even though the sheet original is present on the sheet bed 71 or the ejection tray 82. By the interruption, the second reading mechanism R2 is allowed to perform the reading of an original placed on the contact glass 62. The interruption is entered through the control panel 50 of Fig. 6.

Fig. 8 shows another image forming apparatus according to the embodiment of the present invention. As shown in Fig. 8, the image forming apparatus does not have the ADF 250. In accordance with the removal of the ADF 250, the pressure plate 70 is differently configured. Therefore, other than the removal of the ADF 250, the image

forming apparatus of Fig. 8 basically remain same as that of Fig. 5. In the image forming apparatus of Fig. 8, the surface of the original facing the contact glass 62 is read by the second reading mechanism R2 during one scanning process, while both surfaces of the original can be read with the first and second reading mechanisms R1 and R2 during one transfer process in the image forming apparatus of Fig. 5. When an original is placed on the contact glass 62 in the image forming apparatus of Fig. 5, the surface of the original facing the contact glass 62 is read by the second reading mechanism R2 during one scanning process.

In both image forming apparatuses of Figs. 5 and 8, the page order of the recording sheets P stacked in the stacker 40 and those stacked in the ejection tray 44 are different, as described above. Accordingly, the image forming apparatuses of Figs. 5 and 8 are configured to control the page order of the recording sheets P ejected either to the stacker 40 or the ejection tray 44 in a manner as described above when originals are read with either the first reading mechanism R1 or the second reading mechanism R2.

Fig. 9 is a table summarizing a relationship between manners of reading originals and manners of recording pages which are achieved by the image forming apparatuses of Figs. 5 and 8. In the table of Fig. 9, an item I indicates which one of the first reading mechanism R1 and the second reading mechanism R2 is used and an item II indicates whether an original is of single-sided, abbreviated as S-S, or double-sided, abbreviated as D-S. Further, an item III indicates an order of page reading, in which a page number in bracket indicates a blank page. Further, an item IV indicates which one of the stacker 40 and the ejection tray 44 is used and an item V indicates which one of the single-side recording, abbreviated as S-S, and the double-side recording, abbreviated as D-S is performed. Further, an item VI indicates an order of page generation and an

item VII indicates processes performed. In item VII, a process 1 transfers an image from the photoconductive drum 1 to the intermediate transfer belt 10, a process 2 transfers an image from the photoconductive drum 1 to the recording sheet P, and a process 3 transfers an image from the intermediate transfer belt 10 to the recording sheet P.

In the image forming apparatus of Fig. 8, a sheet path for ejecting the recording sheet P to the stacker 40 is configured to turn the recording sheet P so that the recording sheet P is ejected to the stacker 40 in a face down manner. This operation is referred to as a reverse ejection. A sheet path for ejecting the recording sheet P to the ejection tray 44 is configured to eject it in a straight manner so that the recording sheets P are stacked in the ejection tray 44 in a face up manner. This operation is referred to as a straight ejection. Therefore, in order to eject the recording sheets P in order of pages, an order of generating pages is different between the cases of ejection to the stacker 40 and to the ejection tray 44.

This apparatus of Fig. 8 uses a method of the double-side recording in which two pages of images for the first and second surfaces are stored before starting the image forming process and the photoconductive drum 1 and the intermediate transfer belt 10 are effectively involved in the image forming process without being stopped.

In the table of Fig. 9, the reading manner a and b represent the sheet scanning mode of the image forming apparatus of Fig. 5 and the reading manner c and d represent the book scanning mode of the image forming apparatuses of Figs. 5 and 8. In the reading manner b and d, the fourth page is a white page and so indicated.

The recording manner A and B represent the cases ejecting the recording sheets P to the stacker 40 and the recording manner C and D represent the cases ejection the

recording sheets P to the ejection tray 44.

Combination of the above reading manner and the recording manner makes sixteen different image reading and recording methods. Amongst the sixteen methods, when single-sided originals are read with the ADF 250 in the sheet scanning mode, the original is read by the CCD 68 under the conditions that the moving members 65 and 66 are stopped at the reading position under the contact glass 63 since the first page of the originals faces up in the sheet bed 71 of the ADF 250. When double-sided originals are read with the ADF 250 in the sheet scanning mode, the even page is read by the image sensor 78 and the odd page is read by the CCD 68 with the moving members 65 and 66 stopped at the reading position under the contact glass 63. When single-sided or double-sided originals are read sheet by sheet in the book scanning mode, the original is read by the CCD 68 moved with the moving members 65 and 66. In this case, the original placed on the contact glass 62 is manually turned.

Next, each of the sixteen methods is explained.

(1) In a method "Aa," single-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P in the single-side recording mode, and the single-sided recording sheets P are in turn ejected to the stacker 40. The originals are transferred by the ADF 250 sheet by sheet and are read in order of pages 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages 1, 2, 3, 4, and so on. Each of the formed images is transferred from the photoconductive drum 1 to the recording sheet P (i.e., the process 2) and is ejected to the stacker 40. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1,

2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

In reading the single-sided originals in increasing order of sheet numbers, the sheet that is first read is not called the first sheet but the sheet that has the first page is called the first sheet, as in the case of the recording process. Likewise, in reading double-sided originals, the sheet that has the first and second pages is called first sheet and the reading is performed in increasing order of pages and sheet numbers.

Some reading apparatuses are configured to read originals from the last sheet. Accordingly, the last page is first read and the reading is performed in decreasing order of pages. In these apparatuses, the sheet that is first read may be the first sheet although it has the last page.

(2) In a method "Ab," double-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P in the single-side recording mode, and the resultant single-sided recording sheets P are in turn ejected to the stacker 40. The originals are transferred by the ADF 250 sheet by sheet and are read in order of even and odd pages, such as 2, 1, 4, 3, and so on. This is because the image sensor 78 that reads even page locates upstream and the contact glass 63 that reads odd page locates downstream. The images are formed on the photoconductive drum 1 in order of pages 1, 2, 3, 4, and so on. However, the fourth page is detected as a white page by the image sensor 78 and therefore no image is formed for the fourth page. Each of the formed images is transferred from the photoconductive drum 1 to the recording sheet P (i.e., the process 2) and is ejected to the stacker 40. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the double-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(3) In a method "Ac," single-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P in the single-side recording mode, and the resultant single-sided recording sheets P are in turn ejected to the stacker 40. The single-sided originals are placed on the contact glass 62 sheet by sheet in a desired order, or in an increasing order of pages such as 1, 2, 3, 4, and so on, for example, by the user. The originals are then read with the second reading mechanism R2 in order of placements by the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages 1, 2, 3, 4, and so on. Each of the formed images is transferred from the photoconductive drum 1 to the recording sheet P (i.e., the process 2) and is ejected to the stacker 40. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(4) In a method "Ad," double-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P in the single-side recording mode, and the resultant single-sided recording sheets P are in turn ejected to the stacker 40. The double-sided originals are placed on the contact glass 62 sheet by sheet in increasing order of page such as 1, 2, 3, 4, and so on, for example, by the user. The originals are then read with the second reading mechanism

R2 in order of placements by the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages 1, 2, 3, 4, and so on. However, since the fourth page is a white page, the user does not let it read and therefore no image is formed for the fourth page. Each of the formed images is transferred from the photoconductive drum 1 to the recording sheet P (i.e., the process 2) and is ejected to the stacker 40. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the double-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(5) In a method "Ba," single-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P in the double-side recording mode, and the double-sided recording sheets P are in turn ejected to the stacker 40. The single-sided originals are transferred by the ADF 250 sheet by sheet and are read in order of pages 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of even and odd pages, such as 2, 1, 4, 3, and so on. The double-side recording process is as follows. An image of the even page is transferred from the photoconductive drum 1 to the intermediate transfer belt 10 (i.e., the process 1). An image of the odd page is transferred from the photoconductive drum 1 to the second surface of the recording sheet P (i.e., the process 2). The image of the even page is transferred from the intermediate transfer belt 10 to the first surface of the recording sheet P (i.e., the process 3). Then, the double-sided recording sheet P is ejected to the stacker 40. The processes 1 – 3 are repeated. Thereby, the double-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(6) In a method "Bb," double-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P in the double-side recording mode, and the double-sided recording sheets P are in turn ejected to the stacker 40. The double-sided originals are transferred by the ADF 250 sheet by sheet and are read in order of even and odd pages such as 2, 1, 4, 3, and so on. The images are formed on the photoconductive drum 1 in order of pages as being read, such as 2, 1, 4, 3, and so on, in the double-side recording mode (i.e., the processes 1 – 3). Then, the double-sided recording sheet P is ejected to the stacker 40. In the above procedure, however, the fourth page is a white page which is detected by the image sensor 78. In this case, no image is formed the fourth page and the image of the third page is generated through the process 2. Thereby, the double-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(7) In a method "Bc," single-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P in the double-side recording mode, and the double-sided recording sheets P are in turn ejected to the stacker 40. The single-sided originals are placed on the contact glass 62 sheet by sheet in a desired order, or in an increasing order of pages, by the user. The originals are then read with the second reading mechanism R2 in order of placements by

the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of even and odd pages, such as 2, 1, 4, 3, and so on, in the double-side recording mode (i.e., the processes 1 – 3). Then, the double-sided recording sheet P is ejected to the stacker 40. The processes 1 – 3 are repeated for each cycle of the double-side recording mode. Thereby, the double-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(8) In a method "Bd," double-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P in the double-side recording mode, and the double-sided recording sheets P are in turn ejected to the stacker 40. The double-sided originals are placed on the contact glass 62 sheet by sheet in a desired order, or in an increasing order of pages from the first page, for example, by the user. The originals are then read with the second reading mechanism R2 in order of placements by the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The fourth page, however, is a white page and the user would normally not let it read. Therefore, after the placement of the third page on the contact glass 62, the user can instruct a start of the recording through the control panel 50. The images are formed on the photoconductive drum 1 in order of even and odd pages such as 2 and 1 in the double-side recording mode through the processes 1 – 3 and the image of the third page is generated through the process 2. Then, the double-sided recording sheet P are in turn ejected to the stacker 40. Thereby, the double-sided recording sheets P are stacked face down in the proper page order. As described above, even when the

last page is a white page, the user can simply start the recording by, for example, pressing a start button on the control panel 50 so as to obtain the proper double-sided output including the last page.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(9) In a method "Ca," single-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P in the single-side recording mode, and the single-sided recording sheets P are in turn ejected to the ejection tray 44. The single-sided originals are transferred by the ADF 250 sheet by sheet and are read in order of pages 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages as being read, such as 1, 2, 3, 4, and so on. Each formed image is recorded on the first surface of the recording sheet P through the processes 1 and 3. More specifically, the image is transferred from the photoconductive drum 1 to the intermediate transfer belt 10 (i.e., the process 1) and is further transferred from the intermediate transfer belt 10 to the recording sheet P (i.e., the process 3). Then, the double-sided recording sheet P is ejected straight to the ejection tray 44. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(10) In a method "Cb," double-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P

in the single-side recording mode, and the resultant single-sided recording sheets P are in turn ejected to the ejection tray 44. The originals are transferred by the ADF 250 sheet by sheet and are read in order of even and odd pages, such as 2, 1, 4, 3, and so on. The images are formed on the photoconductive drum 1 in order of pages 1, 2, 3, 4, and so on. However, the fourth page is detected as a white page by the image sensor 78 and therefore no image is formed for the fourth page. Each of the formed images is transferred from the photoconductive drum 1 to the intermediate transfer belt 10 (i.e., the process 1) and then from the intermediate transfer belt 10 to the first surface of the recording sheet P (i.e., the process 3). The recording sheet P having the image on the lower surface thereof is ejected to the ejection tray 44. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the double-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(11) In a method "Cc," single-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P in the single-side recording mode, and the resultant single-sided recording sheets P are in turn ejected to the ejection tray 44. The single-sided originals are placed by the user on the contact glass 62 sheet by sheet in a desired order, or in an increasing order of pages such as 1, 2, 3, 4, and so on, for example. The originals are then read with the second reading mechanism R2 in order of placements by the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages 1, 2, 3, 4, and so on. Each of the formed images is transferred eventually to the lower surface of the recording sheet P via the

processes 1 and 3, and is ejected to the ejection tray 44. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(12) In a method "Cd," double-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P in the single-side recording mode, and the resultant single-sided recording sheets P are in turn ejected to the ejection tray 44. The double-sided originals are placed by the user on the contact glass 62 sheet by sheet in increasing order of page such as 1, 2, 3, 4, and so on, for example. The originals are then read with the second reading mechanism R2 in order of placements by the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages 1, 2, 3, 4, and so on. However, since the fourth page is a white page, the user does not let it read and therefore no image is formed for the fourth page. Each of the formed images is transferred from the photoconductive drum 1 eventually to the lower surface of the recording sheet P through the processes 1 and 3, and is ejected to the ejection tray 44. Thereby, the single-sided recording sheets P are stacked face down in the proper page order.

Thus, the double-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant single-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(13) In a method "Da," single-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P in the

double-side recording mode, and the double-sided recording sheets P are in turn ejected to the ejection tray 44. The single-sided originals are transferred by the ADF 250 sheet by sheet and are read in order of pages 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages as being read such as 1, 2, 3, 4, and so on. In this case, the single-side recording performs the processes 1 – 3 so that an image of the odd page is transferred to from the photoconductive drum 1 via the intermediate transfer belt 10 to the lower surface of the recording sheet P (i.e., the process 1 and 2) and an image of the even page is transferred from the photoconductive drum 1 to the upper surface of the recording sheet P (i.e., the process 3). Then, the double-sided recording sheet P is ejected to the ejection tray 44. The processes 1 – 3 are repeated. Thereby, the double-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(14) In a method "Db," double-sided originals are read with the first reading mechanism R1, the read images are in turn reproduced on the recording sheets P in the double-side recording mode, and the double-sided recording sheets P are in turn ejected to the ejection tray 44. The double-sided originals are transferred by the ADF 250 sheet by sheet and are read in order of even and odd pages such as 2, 1, 4, 3, and so on. The images are formed on the photoconductive drum 1 in order of pages such as 1, 2, 3, 4, and so on in the double-side recording mode (i.e., the processes 1 – 3). Then, the double-sided recording sheet P is ejected to the ejection tray 44. In the above procedure, however, the fourth page is a white page which is detected by the image

sensor 78. In this case, no image is formed the fourth page and the image of the third page is generated on the lower surface of the recording sheet P through the processes 1 and 3. Thereby, the double-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(15) In a method "Dc," single-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P in the double-side recording mode, and the double-sided recording sheets P are in turn ejected to the ejection tray 44. The single-sided originals are placed on the contact glass 62 sheet by sheet in a desired order, or in an increasing order of pages, by the user. The originals are then read with the second reading mechanism R2 in order of placements by the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The images are formed on the photoconductive drum 1 in order of pages as being read such as 1, 2, 3, 4, and so on in the double-side recording mode (i.e., the processes 1 – 3). Then, the double-sided recording sheet P is ejected to the ejection tray 44. The processes 1 – 3 are repeated for each cycle of the double-side recording mode. Thereby, the double-sided recording sheets P are stacked face down in the proper page order.

Thus, the single-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

(16) In a method "Dd," double-sided originals are read with the second reading mechanism R2, the read images are in turn reproduced on the recording sheets P

in the double-side recording mode, and the double-sided recording sheets P are in turn ejected to the ejection tray 44. The double-sided originals are placed on the contact glass 62 sheet by sheet in a desired order, or in an increasing order of pages from the first page, for example, by the user. The originals are then read with the second reading mechanism R2 in order of placements by the user, i.e., in increasing order of pages such as 1, 2, 3, 4, and so on. The fourth page, however, is a white page and the user would normally not let it read. Therefore, after the placement of the third page on the contact glass 62, the user can instruct a start of the recording through the control panel 50. The images are formed on the photoconductive drum 1 in order of pages 1 and 2 in the double-side recording mode (i.e., the processes 1 – 3) and the image of the third page is generated through in the single-side recording mode (i.e., the processes 1 and 3). Then, the double-sided recording sheet P are in turn ejected to the ejection tray 44. Thereby, the double-sided recording sheets P are stacked face down in the proper page order. As described above, even when the last page is a white page, the user can simply start the recording by, for example, pressing the start button on the control panel 50 so as to obtain the proper double-sided output including the last page.

Thus, the double-sided originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant double-sided recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

In the above description, the operation for handling four pages of originals is exemplified. However, it is noted that the image forming apparatus of Fig. 5 can handle any number of pages of originals in accordance with the table of Fig. 9 so as to output the recorded sheets in the proper page order.

As described above, in any one of the sixteen cases, the originals are read in

increasing order of sheet numbers 1, 2, 3, and so on, and the resultant recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

Therefore, in both double-side and single-side recording modes, the user can easily check the contents of the recorded images. In addition, the user can easily restart the reproduction operation when a disturbance is caused due to a paper jam.

Further, since the image forming apparatus of Fig. 5 reads the originals from the first sheet and outputs from the first sheet, it can perform the image forming operation in a time faster than the apparatus that reads the originals from the last sheet and outputs from the first sheet.

Further, since the image forming apparatus of Fig. 5 reads the originals from the first sheet and outputs from the first sheet, two pages of images are needed to be stored. This is far small in comparison to the case of an apparatus that reads the originals from the last sheet and outputs from the first sheet.

In the image forming apparatus of Fig. 5, temperature of the fixing rollers 18 and 19 can be controlled. This feature may be applied also to other embodiments of the present invention. By a control of temperature of the fixing rollers 18 and 19, the fixing process can be performed in an optical condition in accordance with the mode of image forming such as the single-side or double-side recording and the type of recording sheet used such as a thick or thin recording sheet. For example, the double-side recording requires an amount of fixing energy greater than the single-side recording. Therefore, input voltages to the fixing rollers 18 and 19 may be increased or may be applied in a more frequent manner. In addition, in the single-side recording mode, the temperature of the fixing roller at a side of the recording sheet having no image may be controlled to be reduced or the input voltage to it may be turned off.

In the image forming apparatus of Fig. 5, the toner image transferred onto the intermediate transfer belt 10 needs to be prevented from melting due to the high temperature of the fixing rollers. To achieve this, an application of temperature to the fixing rollers 18 and 19 is stopped or controlled during the process for transferring the toner image from the photoconductive drum 1 to the intermediate transfer belt 10. As a result, the toner image on the intermediate transfer belt 10 is prevented from melting due to the high temperature of the fixing rollers.

In the image forming apparatus of Fig. 5, the intermediate transfer belt 10 is closely contacted by the fixing rollers 18 and 19, which may adversely affect the toner image on the intermediate transfer belt 10. To avoid this happens, the cooling rollers 16 are arranged to cool down the intermediate transfer belt 10.

Fig. 10 shows an image forming system includes the image forming apparatus of Fig. 5 added with additional apparatuses. As shown in Fig. 10, the image forming system includes sheet banks PT1 and PT2 and additional ejection apparatuses EXT1 and EXT2. The sheet banks PT1 and PT2 are arranged under the sheet cassette 26. The ejection apparatus EXT1 is arranged at a side of the ADF 250 and over the manual sheet inlet 35 and the ejection apparatus EXT2 is arranged at another side of the ADF 250 and over the ejection tray 44. Each of the ejection apparatuses EXT1 and EXT2 includes a plurality of bins each for receiving the ejected recording sheets P. Each of the ejection apparatuses EXT1 and EXT2 may be a sorter for grouping recording sheets by sorting the recording sheets in page order or a collator for grouping recording sheets by collating the recording sheets with the same page number. It is also possible to install a stapling machine for stapling each stack of sheets sorted by the sorter or collated by the collator.

An additional sheet path Q1 is provided in the sheet ejection space above the stacker 40 to guide the recording sheet P sent from the ejection rollers 34 to the ejection apparatus EXT1. A switching pawl 41 is provided to an edge portion of the sheet path Q1 close to the ejection rollers 34 to switch ways to guide the recording sheet P to the stacker 40 or to the ejection apparatus EXT1. The sheet path Q1 is arranged at the uppermost position of the ejection space over the stacker 40 such that the stacker 40 can be used without being disturbed by the sheet path Q1.

An additional sheet path Q2 is arranged to guide the recording sheet P ejected from the ejection rollers 32 to the ejection apparatus EXT2. A switching pawl is provided at an edge portion of the sheet path Q2 close to the ejection rollers 32 so as to switch ways to guide the recording sheet P to the ejection tray 44 or to the ejection apparatus EXT2.

When the recording sheet P is ejected to the ejection apparatus EXT1, it is reversed and is ejected in the same orientation as in the case of the ejection to the stacker 40. Therefore, the rules of the sheet handling shown in the table of Fig. 9 can be applied to the case of handling the recording sheet P using the ejection apparatus EXT1.

When the recording sheet P is ejected to the ejection apparatus EXT2, it is not reversed and is ejected in the same orientation as in the case of the ejection to the ejection tray 44. Therefore, the rules of the sheet handling shown in the table of Fig. 9 can be applied to the case of handling the recording sheet P using the ejection apparatus EXT1.

As an alternative system, it is possible to configure a system of the printer 100 of Fig. 2 with addition of the ejection apparatuses EXT1 and EXT2, although the printer 100 has no scanning machine.

Next, another image forming apparatus according to the embodiment of the present invention is explained with reference to Fig. 11. The image forming apparatus of Fig. 11 includes a printer 100C, the scanner 200B, an ADF (automatic document feeder) 250B. The printer 100C is similar to the printer 100 of Fig. 2, except for a fixing unit 30B which is arranged outside of the intermediate transfer belt 10. The scanner 200B is similar to that of Fig. 5, except for a contact glass 62b which is substituted for the contact glasses 62 and 63. The ADF 250B is configured to circulate originals.

In the image forming apparatus of Fig. 11, the recording sheet P having the transferred toner image thereon is transferred to the fixing unit 30B and is subjected to the fixing process thereby after being separated from the intermediate transfer belt 10. Although the fixing unit 30B is arranged not inside but outside the intermediate transfer belt 10, it is necessary that the fixing unit 30B is close to the intermediate transfer belt 10 so as to prevent the recording sheet P from becoming bent under the condition of which the unfixed toner image may be disturbed. This is possible since the intermediate transfer belt 10 has a property of heat resistance. This arrangement eliminates necessity of a conveyor having star-like wheels between the intermediate transfer belt 10 and the fixing unit 30B.

In addition, the cleaning unit 25 of the printer 100C is configured to clean the intermediate transfer belt 10 directly with the cleaning blade 25b.

The ADF 250B is provided with the sheet bed 71, the moving plate 72 and the sheet transfer mechanism 73 having the transfer roller 74, the separation rollers 75, and transfer rollers 76, as in the case of Fig. 5.

The ADF 250 includes a transfer belt 90, a driving roller 91, a following roller

92, and a plurality of pressing rollers 93. The transfer belt 90 is arranged at a lower part of the ADF 250B and is extended under pressure between the driving roller 91 and the following roller 92 so as to be rotated therebetween. The positions of the driving roller 91 and the following roller 92 can be exchanged to each other. The pressing roller 93 are arranged inside the transfer belt 90 such that the transfer belt 90 applies a slight pressure to the contact glass 62b when the ADF 250B is in a closed state to read originals.

The ADF 250B further includes a turn roller 94, a following roller 95, a switching pawl 96, a supporting shaft 97, a guide member 98, an ejection tray 99, a pair of ejection rollers 101, a guide member 102, and a cover 103. The turn roller 94 is arranged to the right side of the transfer belt 90 and in contact with the following roller 95 under pressure. The switching pawl 96 is arranged between the turn roller 94 and the ejection rollers 101 and is pivoted about the supporting shaft 97 by an actuator such as a solenoid (not shown), for example. The guide member 98 is arranged between the turn roller 94 and the transfer belt 90.

In the ADF 250B structured in the way as described above, an original is transferred to the contact glass 62b and is stopped thereon. Then, the original is read by the scanner 200 in the way as described earlier with reference to Fig. 5. When the original is double-sided, the original is turned after one side is read so that the other side is read.

An original can be placed on the contact glass 62c manually by the user by opening the ADF 250B.

A stack of the sheet-formed originals S are placed on the moving plate 72 with the first page positioned uppermost and the leading edge thereof is pressed against the

transfer roller 74 with a pressure member (not shown). The transfer roller 74 is rotated clockwise, as shown in Fig. 11, and consequently the first sheet on the top of the stack is fed to a nip portion of the separation rollers 75. Thereby, the stack of the originals are transferred sheet by sheet. The original is further transferred to a nip portion between the transfer belt 90 and the contact glass 62b via the transfer rollers 76. A cover of the sheet transfer mechanism 73 is configured to open so that the user is allowed to access an inside sheet path to remove paper jam.

The transfer belt 90 can be movable in directions indicated by arrows C1 and C2. When the transfer belt 90 is moved in the direction C1, the original is transferred in the forward direction. The transfer belt 90 is stopped in a predetermined time so as to locate the original at a predetermined reading position on the contact glass 62b. Then, the first page of the original is scanned with the light source 64 (Fig. 5) and the moving members 65 and 66 (Fig. 5). After that, the transfer belt 90 is moved in the direction C to further transfer the original to the turn roller 94.

The original is transferred into the nip between the turn roller 94 and the following roller 95 and is turned along the guide member 102 and the switching pawl 96 which is switched to an upper position indicated by an upward arrow. Then, the original is guided under the transfer belt 90 by the guide member 98. At this time, the transfer belt 90 is moved in the direction C2 for a predetermined time period so as to transfer the original to the predetermined reading position. Then, the second page of the original is read in the same manner as the first page is read. After a completion of reading the second page, the transfer belt 90 is moved in the direction C1 to transfer the original in the forward direction. The switching pawl 96 is switched to a lower position indicated by a downward arrow so that the original is guided in a direction B to ejection rollers

101. Thereby, the original is ejected to an ejection tray 99 and is stacked face down in the ejection tray 99. That is, the first page faces down and the stack of originals are held in increasing order of pages in the ejection tray 99.

The guide member 102 is formed in a plurality of ribs such that the original is transferred with a relatively small area contacting the guide member 102. The guide member 102 is a part of the cover and is configured to be opened so that the user can easily access an internal sheet path to remove paper jam.

It is preferable that the user accesses the image forming apparatus of Fig. 11 at a position in front of it and in a direction perpendicular to the figure of Fig. 11; placing a stack of originals S on the sheet bed 71, removing a stack of read originals S from the ejection tray 99, removing the recorded sheets P from the stacker 40, etc.

The image forming apparatus of Fig. 11 structured as described above is applied with the rules of the sheet handling shown in the table of Fig. 9. That is, the originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

Therefore, in both double-side and single-side recording modes, the user can easily check the contents of the recorded images. In addition, the user can easily restart the reproduction operation when a disturbance is caused due to a paper jam.

Further, since the image forming apparatus of Fig. 11 reads the originals from the first sheet and outputs from the first sheet, it can perform the image forming operation in a time faster than the apparatus that reads the originals from the last sheet and outputs from the first sheet.

Further, since the image forming apparatus of Fig. 11 reads the originals from

the first sheet and outputs from the first sheet, two pages of images are needed to be stored. This is far small in comparison to the case of an apparatus that reads the originals from the last sheet and outputs from the first sheet.

Next, a color image forming apparatus according to the embodiment of the present invention is explained with reference to Fig. 12. The image forming apparatus of Fig. 12 includes the color printer 100B of Fig. 4, the scanner 200 of Fig. 5, and the ADF 250 of Fig. 5. The color image forming apparatus of Fig. 12 is provided with a multi-function controller (not shown) for performing multi-functions as a copying machine, a facsimile machine, and a printer.

The color image forming apparatus of Fig. 12 basically performs the operations in the same manner as the image forming apparatus of Fig. 5 does, except for the following. That is, in the color image forming apparatus of Fig. 12, the intermediate transfer belt 10 is separated away from the photoconductive drum 1 and is stopped on standby after the toner image for the first page is transferred to the intermediate transfer belt 10 when a double-sided original is read. During standby, the toner image for the second page is formed on the photoconductive drum 1. On the other hand, in the image forming apparatus of Fig. 5, neither the photoconductive drum 1 nor the intermediate transfer belt 10 is stopped during the image forming process. This is the difference between the color image forming apparatus of Fig. 12 and the image forming apparatus of Fig. 5.

The first and second reading mechanisms R1 and R2 configured as color scanners for reading color image information of an original in each separation color of red (R), green (G), and blue (B) and convert the read information into electrical signals. A color image sensor of each reading mechanism includes R, G, and B separators and

photoelectric devices to simultaneously read three color images separated in R, G, and B and generates R, G, and B image signals in parallel. Then, an image processing unit (not shown) performs a color conversion to generate color image data of black (Bk), cyan (C), magenta (M), and Yellow (Y) colors in accordance with intensity of the R, G, and B image signals.

The first and second reading mechanisms R1 and R2 perform color scanning operations in the following manner. The first and second reading mechanisms R1 and R2 start scanning on the original upon receiving a scan start signal sent in synchronism with the operations of the color printer 100B, and output image data in each of the four colors. The color printer 100B in turn performs the image forming processes for the four color toner images and overlays them one to another so as to generate a full color toner image. The color image forming apparatus of Fig. 12 is configured to read the image data in each of the four colors during one scanning process so as to be able to capture color image data from the first and second surfaces of a double-sided original during a time of transferring that original.

The color image forming apparatus of Fig. 12 structured as described above is applied with the rules of the sheet handling shown in the table of Fig. 9. That is, the originals are read in increasing order of sheet numbers 1, 2, 3, and so on, and the resultant recording sheets P are output in increasing order of sheet numbers 1, 2, 3, and so on.

Therefore, in both double-side and single-side recording modes, the user can easily check the contents of the recorded images. In addition, the user can easily restart the reproduction operation when a disturbance is caused due to a paper jam.

Further, since the color image forming apparatus of Fig. 12 reads the originals

from the first sheet and outputs from the first sheet, it can perform the image forming operation in a time faster than the apparatus that reads the originals from the last sheet and outputs from the first sheet.

Further, since the color image forming apparatus of Fig. 12 reads the originals from the first sheet and outputs from the first sheet, two pages of images are needed to be stored. This is far small in comparison to the case of an apparatus that reads the originals from the last sheet and outputs from the first sheet.

In the above-described printer 100 of Fig. 2 and the color printer 100B of Fig. 5, the intermediate transfer belt 10 may be reverse-turned to a predetermined position after the first toner image is transferred onto the intermediate transfer belt 10, instead of being moved for one turn in the forward direction. In this case, the photoconductive drum 1 and the intermediate transfer belt 10 is configured to be able to contact with and separate from each other.

In addition, the printer 100 and the color printer 100B may employ a belt-shaped photoconductive member in place of the photoconductive drum 1.

Numerous additional modifications and variations of the present application are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the present application may be practiced otherwise than as specifically described herein.

This application claims priority to Japanese patent applications, No. JPAP2000-231576 filed on July 31, 2000, No. 2000-231575 filed on July 31, 2000, and No. JPAP2001-185475 filed on June 19, 2001 in the Japanese Patent Office, the entire contents of which are hereby incorporated by reference.